Report Number: DLAD002 **Report Date(s):** 13 Aug 01

Previous Report Number: 98AYP023 **Previous Report Date:** 9 Sep 98

Title: Performance Oriented Packaging Testing of a 55-Gallon, Forged Lug, Steel, Open Head Drum (1.4 mm/1.1 mm/1.1 mm), With 1-Gallon, F-Style, Rectangular Metal Cans (Quantity of 12) for Liquids-Packing Groups I, II, and III (Surface & Air Modes)(Not for Military Air)

Responsible Individual: Francis S. Flynn

Performing Activity: LOGSA Packaging, Storage, and Containerization Center
ATTN: AMXLS-T
11 Hap Arnold Boulevard
Tobyhanna, PA 18466-5097

Performing Activity's Reference(s): TE 35-97;
AMC 13-88

Requesting Organization:
Defense Logistics Agency
Defense Distribution Center
ATTN: DDC-J-3/J-4-0
2001 Mission Drive
New Cumberland, PA 17070

Requesting Organization's Reference(s):
DLA Memo, 6 Dec 00

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Part 2. Test Results: ___ single _X_ combination ___ composite

Section I. Pre-test Conditions

For initial testing, one drum was received in new condition.

The following identification schema designates the packaging specimen used for the test(s) indicated.

Specimen No.	Test
A	stack test
A	repetitive-shock vibration test
A	flat onto top, drop test
	flat onto bottom, drop test
	flat onto top circumferential chime, drop test
	flat onto bottom circumferential chime, drop test
	flat onto seam, drop test

Prior to testing, each can was filled, unless otherwise noted, with tap water. Substitution for the actual hazardous item (material) is permitted by *49 CFR §178.602(c).*

Section II. Summary

A. Drop test - 1.8 m **PASS**

B. Leakproofness test - N/A

C. Internal pressure test/Hydrostatic pressure test (liq.) - 22 psi (150 kPa), capable by packing group specification **FAIL**

D. Stacking test - static load, 2,000 lb, 24 hr **PASS**

E. Vibration standard - repetitive-shock, rotary motion 3.35 Hz., 1 hr **PASS**

F. Water resistance test (fiberboard box) - N/A

G. Compatibility test (liq. in plastics) - N/A

Part 2. Test Results (continued)

Section III. Discussion

A. Drop test: *49 CFR §178.603*

___ cold conditioned (0° F, 72 hr)
_X_ ambient conditions (~72° F)
___ standard conditions (23° C & 50% RH)

No.	Ht.	Orientation	Results
A	1.8 m	Flat onto top	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Flat onto bottom	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Diagonally onto top circumferential chime	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Diagonally onto bottom circumferential chime	Pass/No leaks/rupture; entire contents retained
A	1.8 m	Flat onto seam	Pass/No leaks/rupture; entire contents retained

For each orientation for the drop test, a quick release hook, fixed to an overhead crane, was used to lift the drum 1.8 meters (71 in.). The impact surface was a ¾-inch steel plate bolted to the concrete floor.

The decision to use the same container (configuration) for all five drop orientations was based on the relatively minimal damage demonstrated during previous testing of MS27684 drums with different inner containers or articles. Five drops per configuration exceeds *49 CFR §178.603* requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or circumferential chime per drum). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

B. Leakproofness test: *49 CFR §178.604*

N/A. The leakproofness test of inner packaging is not required.

C. Internal Pressure/Hydrostatic Pressure test: *49 CFR §178.605*
For transportation by air, *49 CFR §173.27*, applies.

No.	Pressure	Duration	Reached & Maintained Marked Pressure?
A	150 kPa	5 min.	Reached 150 kPa; failed after 45 seconds

Part 2. Test Results: Section III (continued)

D. Stacking test: *See 49 CFR §178.606.*
___ standard conditions (23° C & 50% RH)
_X_ ambient conditions (~72° F)
___ high temperature conditions (104° F)

No.	Length	Type	Force	Results	Stability Maintained?
A	24 hr	Static	2,000 lb	Pass/No leakage or rupture	Yes

A static top load (2,000 lbs) was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load to be applied was greater than the minimum required for one drum based on the outside drum height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

E. Vibration test: *See 49 CFR §178.608.*

No.	Frequency	Duration	Results
A	3.38 Hz	1 hr	Pass/No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (*49 CFR §173.24a(a)(5)*), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the drum/metal cans combination packaging. The

combination packaging was tested using a 2,000-lb vibration table (rotary motion) that had a
1-inch vertical double amplitude (peak-to-peak displacement) such that the combination packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

F. Water resistance (Cobb Method) test (fiberboard): N/A.
The Cobb Method Test, addressed in (*49 CFR §178.516*), Standards for Fiberboard Boxes, is a material specification test only for the fiberboard to be used for outer packagings.

G. Compatibility test (plastics packagings only): N/A
Compatibility testing (a procedure specified in appendix B to part 173, as required by *49 CFR §173.24(e)(3)(ii))* is only required for plastics packagings intended to contain *liquid* hazardous materials.

Part 3. Test Personnel

The personnel who performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein-- Richard D. LaFave, Samuel Baroody, Bruce W. Samson, Timothy L. Reimann, and Karen K. Kimsey.

Part 4. References

A. Title 49 Code of Federal Regulations, Parts 106 and 180, Spring 2001, current as of 12 Jan 01

B. International Air Transport Association Dangerous Goods Regulations, 40th edition, 1 January 1999

C. ASTM D 4919, Specification for Testing of Hazardous Materials Packagings.

D. ASTM D 999, Standard Method for Vibration Testing of Shipping Containers.

E. ASTM D 951, Standard Test Method Water Resistance of Shipping Containers by Spray Method.

F. TAPPI Standard: T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

G. Recommendations on the Transport of Dangerous Goods, sixth revised edition, United Nations, New York, 1990.

H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/ MCO 4030.40A, Packaging of Hazardous Material, 23 Jul 96

I. AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3, Preparing Hazardous Materials for Military Air Shipments, 1 Mar 97

Part 5. Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
2,000-lb vibration table	L.A.B Skaneateles, NY	G23605	*see note*
30,000-lb compression tester	Gaynes Engr. Co. Franklin Park, IL	G20950	4/02
release hook	Gaynes Engr. Co. Franklin Park, IL	18211-1	N/R

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements.

Appendix A

Test Applicability

Pass/fail conclusions were based on the particular cans and drum specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Reference to specification materials has been made based either on the information provided by the requester, the manufacturer, or the markings printed on, attached to, or embossed on the packagings. It was not possible to identify the exact composition of the drum construction materials.

Testing was performed per *Title 49* Code of Federal Regulations.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein

should not be construed as blanket certification of any configuration which simply uses the performance tested outer drum. Packaging paragraphs apply.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid _X_ liquid ___ gas ___ aerosol

Amount Per Container:

Item Weight-- 109.2 lbs. (12 @ 9.1 lbs. each)
Tare Weight-- 94.8 lbs.
Gross Weight-- 204 lbs.

Density/Specific Gravity: 1.0

Section II. Test Parameters (continued)

Stacking Weight Formula, Liquids – DLA

Variables		Inputs	Calculations	
h	height, drum/box	34.625		
n	# stacked containers	XXXXXXXX	3.41	
w1	weight, drum/box	49		
w2	weight, bottle/can	0.76		
w3	weight, fiberboard pad	.4		
q1	# inner containers	12		
v1	max. volume, 1 inner container	1		
v	total volume	XXXXXXXX		
w4	weight, item (unpacked)	8.33		
W5	weight, absorbent	45.52		
W	total weight	XXXXXXXX	204	
C	constant	1		
A1	Stacking weight-PG I	XXXXXXXX	**774.93**	**775**
A2	Stacking weight-PG II	XXXXXXXX	**916.59**	**917**
A3	Stacking weight-PG III	XXXXXXXX	**1129.06**	**1130**

NOTE: A1 = (n-1)*(w+(1.2*v*8.3*0.98))*(c), Packing Group I
A2 = (n-1)*(w+(1.8*v*8.3*0.98))*(c), Packing Group II
A3 = (n-1)*(w+(2.7*v*8.3*0.98))*(c), Packing Group III

A1 = stacking weight in pounds, PG I
A2 = stacking weight in pounds, PG II

A3 = stacking weight in pounds, PG III
n = (118/h), minimum number of containers that when stacked, reach a height of 3 m
w = w1+(w2*q1)*(w3*q1)*w5, total weight in pounds
v = v1*q1, total volume
c = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)

Appendix B (Continued)

Section III. Equivalencies of Liquids

	Specific Gravity	Total (Each) Amount per Container	Gross Weight (pounds)	(kilograms)
water	1.0	8.33 lb	204	97.73
PG I	1.2	10.0 lb	223.99	101.81
PG II	1.8	15.0 lb	283.97	129.08
PG III	2.7	22.49 lb	373.93	169.97

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus
SG = drop height/PG factor (49 CFR §178.603)
PG I: 1.5 m x SG = 1.8 m, thus SG = 1.2
PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8
PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7
Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

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Appendix C

Packaging Data Sheet

Section I. Exterior Shipping Container

Packaging Category: ___ single _X_ combination ___ composite

UN Type: Steel openhead drum *(49 CFR §178.504)*

UN Code: 1A2 Nominal (Rated) Capacity: 55 gal

UN Marking(s) on Packaging:
label on drum side-- UN1A2/Y1.5/150
01 USA/M4453

embossed on drum bottom-- UN 1A2/Y1.5/150
99
1.4-1.1-1.1

Specification Type and No(s).: N/A

Type/Materials: steel, open head drum, round, sponge gasket

Manufacturer/Distributor: Bernfield Container, Inc., Mason, OH 45040
CAGE 9Z473 CODE MM4453

Date(s) of Manufacture: 99 (embossed on drum bottom)

Nomenclature: Drum, Steel, Shipping and Storage (label marking)

NSN: 8110-00-030-7780 (drum assembly)

Tare Weight (empty drum): 49 lb (includes cover, ring, and bolt)

Dimensions:
- 34? in. OD (drum height, including locking ring)
- 24 15/16 in. OD (drum body diameter, outside ring)
- 22 7/16 in. ID (drum body diameter)
- 33 5/16 in. ID (drum body height)

Closure (Method/Type): Forged lug locking ring, grade 2 bolt

Closure Specification Number(s): Not identified

Appendix C (Continued)

Section II. Inner Packaging/Article

Quantity of Inner Containers: 12 Capacity: 1 gallon each

Specification Type and No(s).: N/A

Type: Oblong, 1-gallon metal can with 1¼" screw neck

Manufacturer/Distributor: Freund Can Company, Chicago, IL

Material(s): Steel, tin plate

Date of Manufacture: Not marked

Tare Weight (empty can): .76 lb

Filled Weight: 9.1 lbs.

Dimensions: 6? in. length (OD)
4? in. width (OD)
10½ in. height (OD) (includes handle)

Closure (Method/Type): Screw cap

Closure Dimensions: 1¼ in. screw cap

Secondary Closure: Filament-reinforced tape (2 pieces, Chris-crossed)

Secondary Closure Specification Number(s): NSN-- 7510-00-582-4772
(1) A-A-1687B, Amendment 1 (marked) [canceled Jan 96]
(2) PPP-T-97, type II (medium tensile), class B (transparent) [canceled Jan 96]
(3) ASTM D 5330-93, type II (medium tensile)

Secondary Closure Dimensions: 1 inch wide

Bag Manufacturer: Quality Packaging Systems, Warren, MI 48091-5324

Bag Closure: 1-inch pressure sensitive, filament reinforced tape IAW ASTM 5330, TY II

Absorbent Material & Vermiculite NSN: 8135-01-324-2664

Absorbent Manufacturer: Absorbent GP, Bellingham, WA 98225

Fiberboard Pad: 22-inches in diameter-- either Grade W5c or V3c

Appendix C (Continued)

Section II. Inner Packaging/Article (Continued)

Additional Description:

a. A plastic liner bag, 30" x 60" x .04", was first placed into the drum to encapsulate the absorbent and test product.

b. Approximately 4 inches of loose fill absorbent was placed in the bottom of the drum. Six F-style cans were placed on the loose fill absorbent cushioning, evenly spaced. Additional loose fill absorbent was then tightly packed around and over the cans. Approximately 1 inch of tightly packed loose fill absorbent separated the cans from each other. Approximately 1 inch of loose fill absorbent separated the cans from the sides of the drum. Approximately 2 inches of firmly packed loose fill absorbent covered the evenly spaced F-style cans. A fiberboard pad was placed on the layer of absorbent cushioning. Approximately 2 inches of loose fill absorbent was placed on the fiberboard pad. Six F-style cans were placed on the absorbent cushioning, evenly spaced. Additional loose fill absorbent was tightly packed around and over the cans. Approximately 4 inches of loose fill absorbent covered the cans. The loose fill absorbent must be firmly packed, especially toward the bottom chime. The loose fill absorbent must completely fill the drum, up to the rim. The plastic bag is to be folded down and then taped across the fold.

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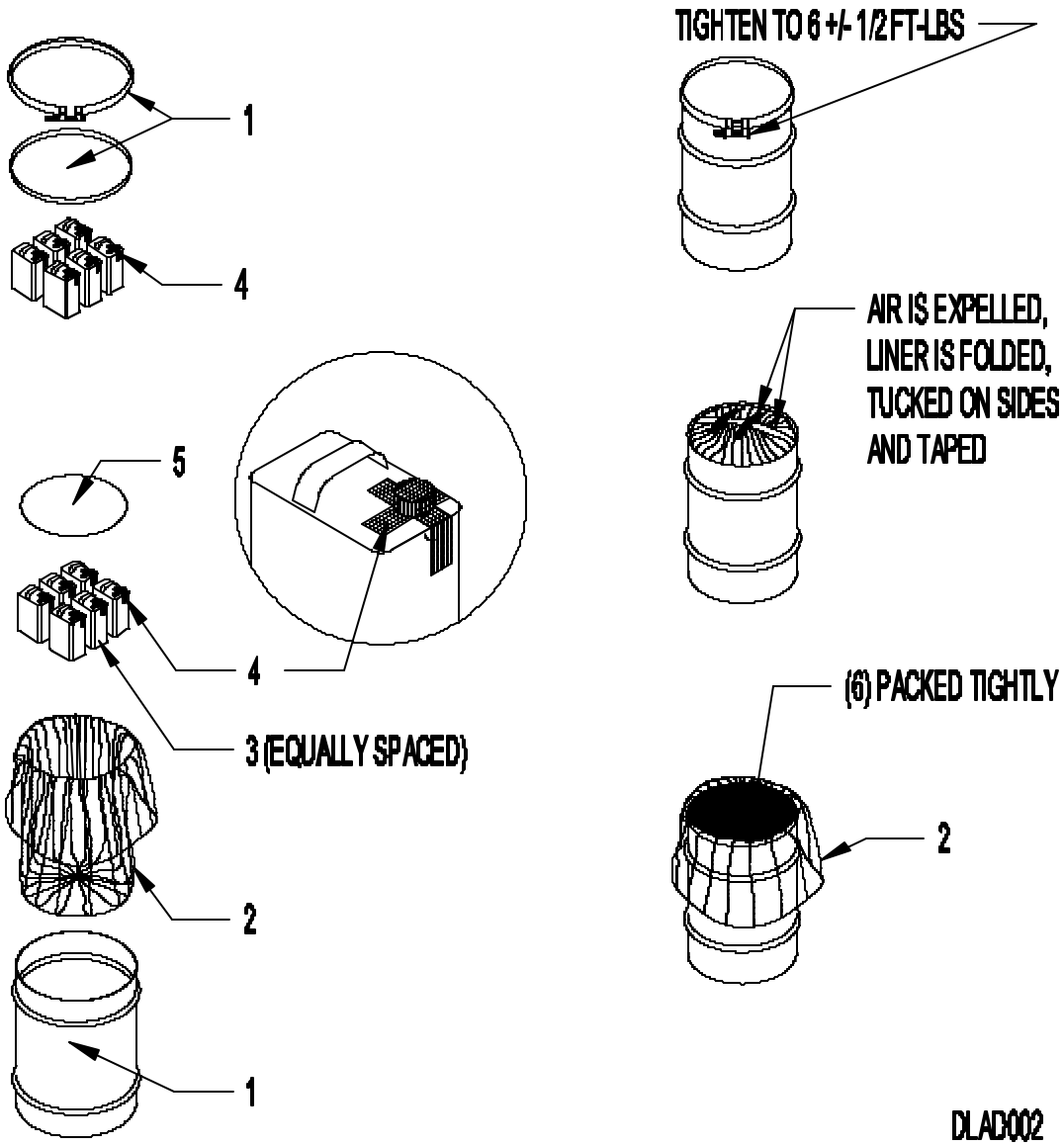
Appendix D



ITEM	DESCRIPTION
1	55 GAL., 1A2 STEEL OPEN HEAD DRUM
2	PLASTIC LINER, 4-MIL POLYETHYLENE BAG, 30 X 60 INCHES
3	1-GALLON, "F" STYLE, RECTANGULAR, METAL CANS, QTY. 12
4	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D 5330, TY II
5	CIRCULAR FIBERBOARD PAD, GRADE V3c IAW ASTM D 4727
6	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450

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Appendix D (Continued)

Photo 1-- F-style cans ready to be packed inside a 55-gallon drum.

Appendix D (Continued)

Photo 2-- View of bottom layer of cans prior to adding the absorbent.

Appendix D (Continued)

Photo 3-- View of the top 6 cans prior to the addition of the absorbent.

Appendix D (Continued)

Photo 4-- Container ready for testing.